# Space Weather Technical Forecast

Issued on Tuesday, 12 December 2023 at 01:08 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

**Space Weather Forecast Headline: Chance of further isolated M-flares, mainly Day 1 (12 Dec).**

**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Low with the peak flare a C4.4 at 11/1532 UTC from AR3511.

There are currently six sunspot regions on the visible disc, following the departure of AR3507 and AR3508 around the west limb. The most active region has been AR3511, but which is also now rotating off the visible disc and has seen its trailing portion decay in recent hours. AR3513 (Eai/Beta-Gamma) is the largest region on the disc at present and continues to evolve slowly, but has shown decay in its intermediate and trailing spots in recent imagery. AR3514 (Cao/Beta) has shown further minor spot emergence/development. All other regions are currently relatively small and simple and are either stable or showing slight signs of decay.

No Earth-directed Coronal Mass Ejections (CMEs) were observed in available imagery. However, a dimming event was observed around 11/2200 UTC in the vicinity of AR3514 associated with a C1 flare. Imagery will be monitored for any potential CME that may have been produced.

**Solar Wind / Geomagnetic Activity:** Solar winds as observed by ACE and DSCOVR at L1 were at slow-ambient levels. Wind speeds as measured by ACE were 310-350km/s, with a slight downward drift. Density has remained below average throughout. The Total Interplanetary Magnetic Field (Bt) was weak, at or below 6nT, while the north-south component (Bz) varied weakly. Phi angle was predominately negative (towards the Sun). Geomagnetic activity was Quiet (Kp 0-1).

**Energetic Particles / Solar Radiation:** GOES16 high energy (greater than 10MeV) proton flux remained at background levels. GOES16 high energy (greater than 2MeV) electron flux was predominantly moderate but briefly peaked at high levels, at 1340pfu at 11/1440UTC. The 24-hour fluence was below the Active threshold (1e8 integrated pfu) but with a slight upward trend. The observation at 12/0000UTC was 4.82e7 integrated pfu.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Generally Low solar activity is expected to continue, with a chance or slight chance of isolated M-flares. These are most likely to emanate from AR3511, AR3513 or AR3514.

**Solar Wind / Geomagnetic Activity:** There are no Earth-directed CMEs currently expected in the forecast period.

Solar winds are most likely to continue at background levels through Day 1 (12 Dec) and most, if

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not all, of Day 2 (13 Dec) ahead of the next coronal hole (79). CH79/+ is a new feature for this rotation, and is expected to become geoeffective sometime on Day 3 (14 Dec). However, confidence is low in timing and peak wind speeds due to the non-persistent nature of this feature, but slightly elevated winds are expected, possibly reaching elevated levels.

The current Quiet (Kp 0-2) geomagnetic activity is likely to continue until the onset of the HSS from CH79/+, which is anticipated to be on Day 3 (14 Dec). There is a slight chance that the onset of the HSS may produce an isolated G1/Minor Geomagnetic Storm interval (Kp 5), but this is considered a low probability at this stage, with Unsettled to Active conditions more likely.

**Energetic Particles / Solar Radiation:** GOES16 high energy proton is expected to persist at background levels, with only a very slight chance of rising towards the S1/Minor Radiation Storm level given any significant flares from AR3511, AR3513 or AR 3514. This risk decreases as AR3511 rotates beyond the western limb. High energy electron flux is expected to be moderate at first, perhaps with diurnal peaks close to, or reaching, the high threshold. A drop out is possible with HSS enhancement on Day 3 (14 Dec). The associated 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold, but perhaps rising closer to Active by Day 4 (15th).

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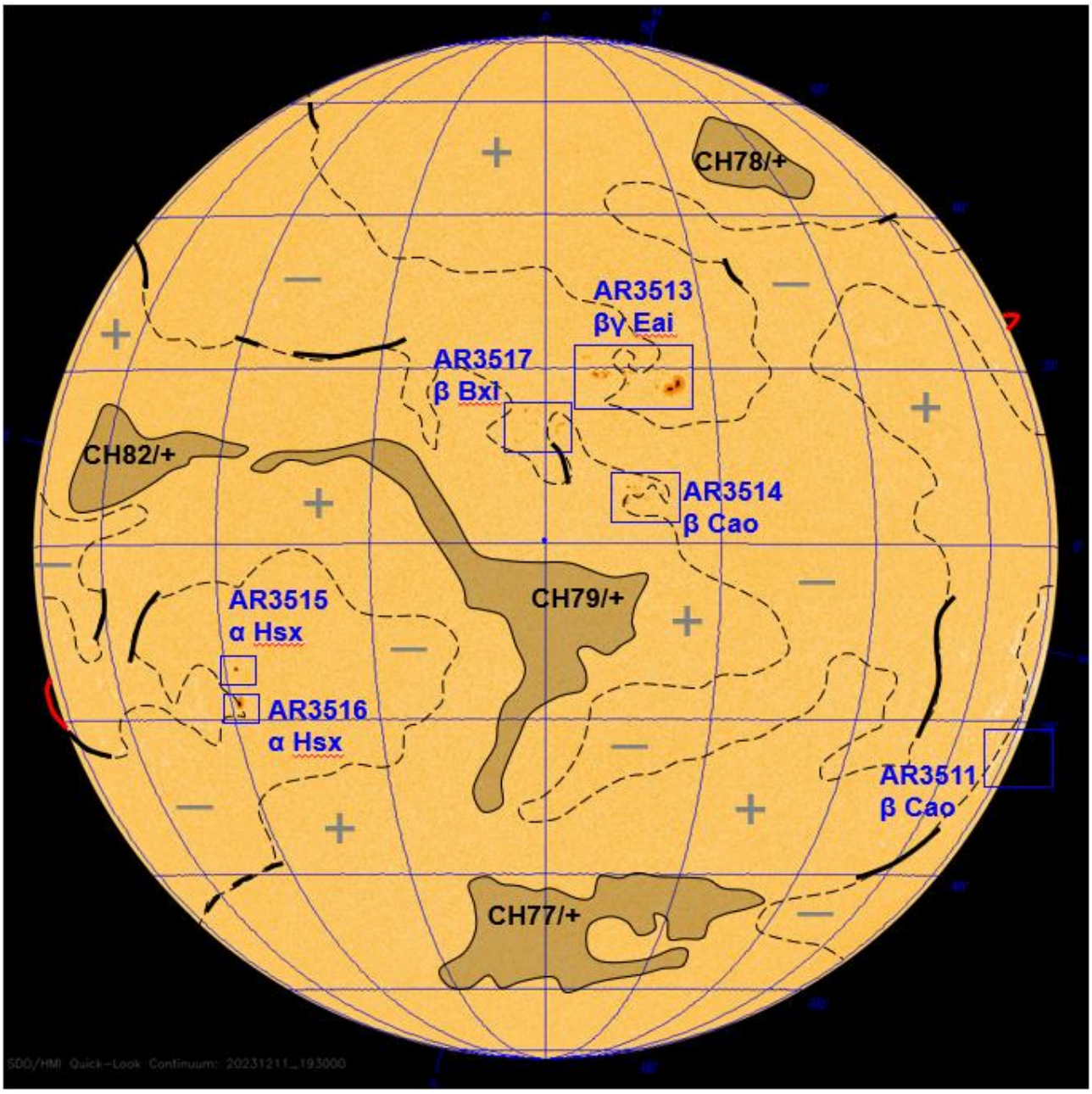
**Figure 1. Solar Analysis Valid 11/2000UTC.**

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**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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## Geomagnetic Storms:

There are no Earth-directed CMEs currently expected in the forecast period. However, a dimming event was observed around 11/2200 UTC in the vicinity of AR3514 associated with a C1 flare. Imagery will be monitored for any potential CME that may have been produced.

Solar winds are most likely to continue at background levels through Day 1 (12 Dec) and most, if not all, of Day 2 (13 Dec) ahead of the next coronal hole (79). CH79/+ is a new feature for this rotation, and is expected to become geoeffective sometime on Day 3 (14 Dec). However, confidence is low in timing and peak wind speeds due to the non-persistent nature of this feature, but slightly elevated winds are expected, possibly reaching elevated levels.

The current Quiet (Kp 0-2) geomagnetic activity is likely to continue until the onset of the HSS from CH79/+, which is anticipated to be on Day 3 (14 Dec). There is a slight chance that the onset of the HSS may produce an isolated G1/Minor Geomagnetic Storm interval (Kp 5), but this is considered a low probability at this stage, with Unsettled to Active conditions more likely.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 5 | 10 | 5 |
| Strong | G3 | No | 1 | 1 | 1 | 1 |
| Severe | G4 | No | 1 | 1 | 1 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

**None expected.**

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**Radio Blackouts - X-Ray Flares:**
Solar activity has been Low with the peak flare a C4.4 at 11/1532 UTC from AR3511. Generally Low solar activity is expected to continue, with a chance or slight chance of isolated M-flares. These are most likely to emanate from AR3511, AR3513 or AR3514. However, AR3511 has now almost entirely passed beyond the western limb and its flare probability contribution will diminish from Day 2.

There are currently six sunspot regions on the visible disc, following the departure of AR3507 and AR3508 around the west limb. The most active region has been AR3511, but which is also now rotating off the visible disc and has seen its trailing portion decay in recent hours. AR3513 (Eai/Beta-Gamma) is the largest region on the disc at present and continues to evolve slowly, but has shown decay in its intermediate and trailing spots in recent imagery. AR3514 (Cao/Beta) has shown further minor spot emergence/development. All other regions are currently relatively small and simple and are either stable or showing slight signs of decay.

Seismic analysis of the far-side would suggest that new regions may rotate onto the east limb in the coming days, supported by areas of brightness visible beyond the east limb on SDO AIA-0094.

| X Ray Flares | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) | Day 2 (00-24 UTC) | Day 3 (00-24 UTC) | Day 4 (00-24 UTC) |
|---|---|---|---|---|---|---|
| Probability | | | (%) | (%) | (%) | (%) |
| Active | R1-R2 M Class | No | 35 | 20 | 20 | 20 |
| Very Active | R3 to R5 X Class | No | 5 | 1 | 1 | 1 |

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## Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at background levels. There is a slight chance of this increasing should there be any significant flares, especially from AR3511 which is now at the southwest limb, and also from AR3513 and AR3514 which are now transiting across the western hemisphere. The risk reduces somewhat by Day 2 (13 Dec) as AR3511 continues to rotate away from beyond the west limb.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 10 | 5 | 5 | 5 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

## High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16, has been mainly moderate over the last few days, with brief diurnal peaks into the high threshold. A suppression is anticipated at some point from Day 3 (14 Dec) with the likely HSS enhancement from CH79/+.

The associated 24 hour fluence is expected to remain below the Active threshold, but may rise closer to the Active threshold by the end of the period, depending on the timing and strength of the next anticipated HSS. The REFM is considered to be giving limited useful guidance at present, with the sharp decline on Day 3 (14 Dec) dependent on the strength of connection with the HSS, which is currently low confidence.

| GEO Electron Environment Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 5 | 10 | 20 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

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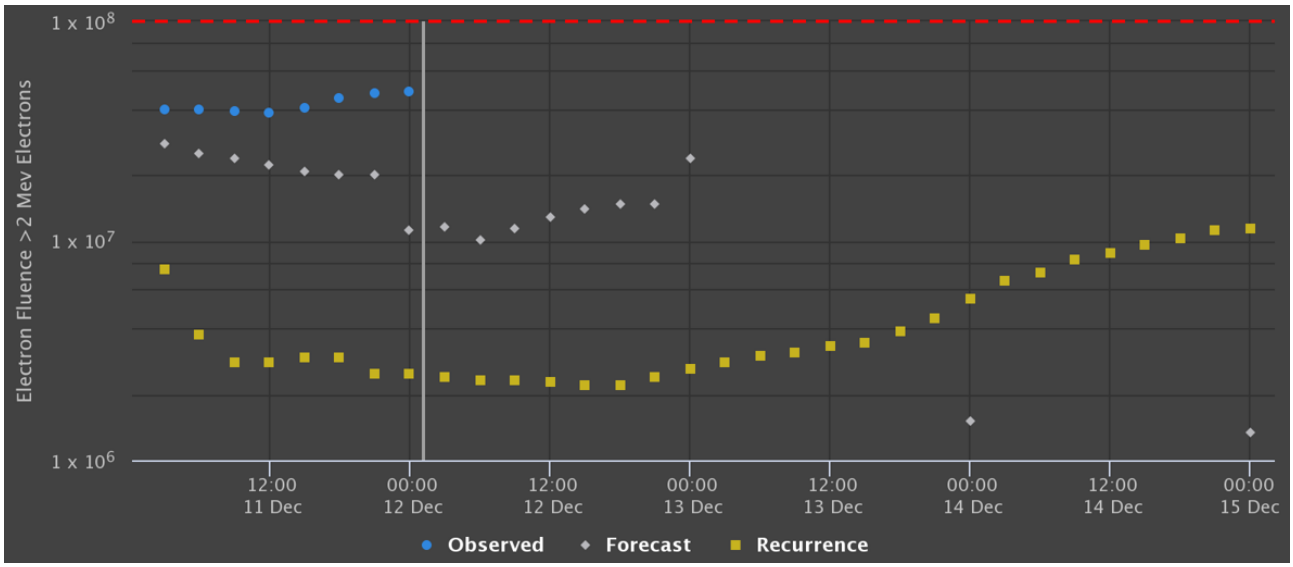
**Figure 2: MOSWOC REFM latest output.**

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